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Analysis of constraints to agricultural production in the Sudan-sahelian zone of Cameroon using a diagnostic survey

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Abstract —The informal diagnostic survey approach was used to identify the major constraints to agricultural production and to describe the major production systems in the Sudano-sahelian zone of Cameroon. Relative emphasis was placed on the household level characterization to have a better understanding of the land use system, farmers' constraints and opportunities, so as to better target agricultural technologies and interventions in this agro-ecological zone. Large variations exist in agriculture management practices among villages and households in terms of access to resources, such as labors, fertilizers, livestock, farm equipment, and land. Intensive and extensive farming practices might co-exist within the same village and households. Results could be used to identify research priorities which will be directed towards the need of the majority of area's population the improvement of sustainable food and feed crop production.

Résumé — Analyse des contraintes à la production agricole dans la zone soudano-sahélienne du Cameroun à partir d'un diagnostic participatif. Une approche de diagnostic participatif a été utilisée pour identifier les principales contraintes à la production agricole et caractériser les systèmes de production dans la zone soudano-sahélienne du Cameroun. L'accent a été mis sur la caractérisation au niveau des ménages pour mieux comprendre les systèmes d'utilisation des terres, les contraintes et possibilités des paysans afin de mieux cibler les technologies et les interventions pour cette zone agro-écologique. Il y a de grandes différences dans les pratiques de gestion agricole entre les villages et les exploitations, en termes d'accès aux ressources comme la main-d'œuvre, les engrais, le bétail, les équipements agricoles et la terre. Des pratiques de cultures intensives et extensives peuvent co-exister au sein des mêmes villages et ménages. Les résultats peuvent également être utilisés pour identifier des domaines prioritaires de recherche qui tiennent compte des besoins des populations de la région afin d'assurer une production durable.

Introduction

Cameroon is situated on the West coast of Africa and extends between latitudes 2^0 and 13^0 N and between longitudes 8^0 and 16^0 E. The country has a great diversity of climate ranging from the humid tropics near the coast where annual rainfall is heavy to the sahelian zone, which has 9 to 10 months dry season. Intervening mountains and plateau areas, which affect both rainfall and temperature, breaks the regular succession of climatic zones from south to North. Agricultural potential are huge with opportunities for agricultural development spanning four main agro-ecological zones, each with its unique characteristic. The Sudano-

Sahelian zone alone extending between latitudes 7^0 $30'$ and 13^0 N and longitudes 9^0 to 15^0 is characterized by a large diversity in term of biophysical (climate, landscape, hydrology,) and socio-economic (land, labors, resources, marketing and tenure practices). More than 60 household ethnic groups can be distinguished in the region. The climate is of the type AW/BS in the Köppen classification (tropical humid with dry winter-semi-arid)(Times, 1992). It is characterized by a unimodal distribution of rainfall and a long dry season. The raining season lasts four months from June to September with two intermediate month of uncertain rainfall, May and October. The major rainfed cereals are sorghum and millet; opportunities also exist for the cultivation of maize, groundnuts, cowpea, vegetables and rice, with cotton the predominant cash crop.

Cropping systems are based on sorghum and millet, but with the increasing population densities, and the increase in fertilizers price, the quest for alternative, but yet productive and sustainable production systems becomes more important. The key factor of production in any agricultural system is labor. It is the human investment which transforms land and capital assets into consumable output. Different societies have fashioned different patterns of labor organization at different stages of their development. In North Cameroon, the coexistence of Moslem and non-Moslem ethnicities affords an analysis of several different patterns of organization. The land use systems and production strategies adopted by farmers depend on the interaction between biophysical and socio-economic resources available to them. It is only through characterization and diagnostic survey at different households that a better understanding of environment in which farmers operate and their constraints can be obtained for accurate targeting of appropriate technologies and policies.

The objectives of this study were to carry out a diagnostic survey in across the Sudano-Sahelian zone of Cameroon (made of two provinces: North and Far-North), to identify constraints to production, and subsequently prioritize research themes requires taking into account the identified constraints for further technology development and testing with farmers.

Materials and methods

A zonation of the North Cameroon and diversity of farming system was proposed by Dugué *et al.,* (1994). The criteria used in delineating the target zone and choosing research location were:
– Ethnic group, population densities and accessibility to land;
– Annual rainfall in term of amount and distribution, soil, vegetation and relief;
– Livestock management, cropping systems and socio-economic environment (Market accessibility, social organization and customs).

For the present study, detailed characterization was carried out in one village selected in each of the seven zones. The villages were chosen to represent the agro-climatic and socio- economic diversity of the zone. Other factors used in selection were the accessibility and representatives of main production systems. Areas where dry season commercial gardening activities are known to be highly developed were avoided. In those villages a participatory rural appraisal survey was conducted from September to December 1998 and activities of household (selected in the basis of interviews) were monitored. Additional interviews with household heads were held to determine their farming practices and resource endowments.

A series of pre-coded questionnaires was developed, modified from the Food and Agricultural Organization's Farm Management Data collection and Analysis computer package (Friedrich, 1977). Certain information was collected in a single passage from each household, those are:
– Complete inventory of household members and original livestock;
– Livestock managements;
– Gross field characteristics, area cropped per field;
– Intercropping patterns, crop rotations over four seasons;
– Land rental market.

Other data was collected during multiple passages:
– Break down of kinds of labor employed by type
– Field area prepared using animal traction
– Fertilizer quantities distributed per field.

Information was asked not only of the head of the household but of each man and woman who cultivated his or her own field.

Results and discussion

Rainfall

The Sudan Savannah zone of North Cameroon may be subdivided into three sub-ecological zones. The sahelo-sudanian zone with rainfall less than 800 mm, the sudano-sahelian zone where the rainfall varied from 800 mm to 1000 mm and the sudano-guinian zone where rainfall varies from 1000 mm to 1300 mm. The growing periods of the sudano-sahelian zone vary from 100 to 150 days while for the sahelo-sudanian zone the growing periods varies from 60 to 100 days. At the scale of agro-ecological zone, the mean annual rainfall for the region during 1998 and 1999 cropping season varied between 600 mm in the northern sub-zone (Far North province) to 1200 mm in the southern sub-zone (North province). The rainfall is variable and undependable. It is characterized by a large inter- annual variability. Monthly variation is larger since rainfall is usually limited to few months, i.e. June to October. Aridity prevails during the rest of the year and is most pronounced from November to April. According to Nicholson (1983), the potential for development of these zones is limited not only by total rainfall, but also by other, less commonly consideration characteristics of the area's rainfall such as spatial variability, intensities, infiltration and runoff.

Soils

Overtime, the various process of soils formation have given rise to important pedological heterogeneity of this part of Sudan savannah zone (Table 1.). Based on a 1:100 000 soil map from ORSTOM (1963) and translated to FAO classification, three major soil types may be distinguished.

- Vertisols: they have three characteristics properties: more than 30% clay, wide and deep cracks at some time of the year and a specific morphology characterized by one or more of the following three criteria, gilgai microrelief, intersecting slickensides, and wedge-shaped structural aggregates (Blokhuis, 1989). They have low available water holding capacities because they may hold water and nutrients so tightly that they become unavailable to plants even though the have high total water holding capacities. The clay are susceptible to crusting and give rise to poor seedling emergence.

- Plano-sols: Poel (Driessen & Dudal, 1989) defines Plano-sols as soil having stagnic properties at least in part of the horizon and abruptly overlying a slowly permeable horizon within 125 mm of the surface, exclusive of a nitric or sodic B-horizon. A common feature of these soils is their low organic and nutrient content, especially nitrogen and phosphorus, shallow root development of the crop and crop sensitivity to spells of drought.

- yLixisols: they are reddish brow and show the translocation of clay from the surface horizon to the sub-soil horizons. The structure is massive with sandy clay loam texture. Organic matter and nitrogen content is low.

Land use

Crop production increases in the region have primarily come from increases in the cultivated area. Land use comprises cereal-based cropping, cotton-based cropping and ruminant-based livestock activities with considerable variability in most characteristics between provinces. Averaged over provinces, farm sizes decreases as one moves from southern sub-zone to Northern sub-zone. Agricultural land falls into two discrete categories: rainy season fields and dry season fields. In the less crowded villages farmer's rainy season field are usually located around the compound. Cotton, the area's primary cash crop has been grown in multi-hectare blocks subdivided into quarter-hectare plots. Sodécoton (Société pour le développement du Coton au Cameroun) the largest industrial force in the region, which organizes all phases of cotton and marketing, sets up the block system in order to standardize plot sizes and facilitate application of animal traction and chemical inputs. In principle, the sites of the blocks are rotated each year to distribute the individual farmer's obligation to give up land to the village block. Very little land if any is left to fallow on a regular basis.

Table 1. Selected characteristics of the sub-zone in the Sudan Sahelien zone of Cameroon.

Zones	South of cotton belt	Pioneer forehead	Periphery of Garoua zone	Mayo Louti and Mayo Kébi zone	Piedmont of Mandara mountain zone	Plain of Kaélé and duck's beak zone	Plains of Diamaré And of Mora zone (North of cotton belt)
	Sudan Savannah zone				Sudan Sahelien zone		
Benchmark	Fignolé	Laïndé	Mafa Kilda	Séboré	Mowo	Gadas	Balaza Domayo
Pop. Density (hab. / km^2)	5-10	10-30	20-60	30-70	50-180	3--180	30-180
People	Autochthons and Migrants	Autochthons and Migrants	Autochthons and Migrants	Autochthon and old Migrants	Autochthons	Autochthons	Autochthons
Land availability	Important	Important	Less important	Weak, not available	Weak in the southern sub-zone	Saturated	Weak
Soils	Lixisols sandy	Lixisols Sandy / clay	Lixisol / hydromophic	Lixisols	Planosols with clay	Vertisol Sandy / clay	Vertiso sandy / clay
Rainfall (mm / an)	1.000-1.500	1.000-1.200	900-1.000	800-900	1.000	700-800	600-700
Animal husbandry	Mbororo Transhumance trypanosomes	Mbororo Transhumance	Sedentary (Bovines, goats,)	Sedentary Bovines and ruminant	Sedentary Limited at the North sub-zone	Semi-sedentary, transhumance Integrated	Semi-sedentary, Transhumance
Cropping systems	Maize / cotton / vegetable or root crop. Herbicides uses Direct seedling	Maize / cotton / vegetable Herbicides uses; Animal traction	Maize / cotton / vegetable Muskuwaari Herbicides Animal traction	Sorghum / groundnut / cotton Animal traction	Sorghum / groundnut / cotton Animal traction	Sorghum / cowpea / cotton Muskuwaari Animal traction	Sorghum / groundnut / cotton Muskuwaari Direct seedling

The cultivation of dry season sorghum crop "Muskuwaari" is one of the North Cameroon 's most unique agricultural phenomena. Seedlings are taken from their rainy season nursery beds one month after planting and transplanted into heavy clay soils, known as "Karal" fields. These "Karé" (plural of Karal) are normally completely flooded during the rainy season, and completely unworkable. As the rains taper off, the karé are prepared for transplanting of muskuwaari seedlings. The moisture absorbed by these swollen vertisols from May to September plus the cup of water added at transplanting time will sustain the Muskuwaari for five months without a single additional drop of water. Muskuwaari is recognized to be one of the preferred consumed grain of the majority of the region's population and has grown in population importance, particularly because cotton cultivation sometime completes with sorghum for land and labor during the rainy season. As the demand for muskuwaari increases, so does the demand for karé. A farmer's karal can be much further away from his house. Because of this great competition for karé, it figures more prominently in the land rental market, than do rainy season food grain or cotton fields.

Though land is generally inherited patrilinally, tenure over land is not always secure. In practice, all land belongs to the Chief. He distributed control of the land to his deputies (Djooros). They in turn oversee the allocation of usufructuary rights to farming families. According to Azarya (1978) the land tenure legislation reinforced the traditional right to land ownership by collectivity units, even not actually cultivated by those units. The practice is still in force today.

The growing land constraint in the area of higher population density suggests that extensification of agricultural practices will no longer be a feasible solution to increase agricultural production, but that intensification of practiced agronomy should be in order.

Cropping systems

Cropping systems in the two provinces are mainly based on sorghum, cotton, and maize. On the south–north axis, the importance of maize decrease and that of sorghum increases, while cotton is the major cash crop regardless of geographical position. In the region, major food crop are sorghum, maize, groundnuts and cowpea. Minor crop included sesame, vegetables, Bambara-nuts grown in a variety of intercrop. Sole crops are predominant in the southern sub-zone were the use of herbicide for weed control is important; but variability in surface cultivated at both provinces and villages is considerable. The average surface cultivated varies from 1.5 ha to 3.1 ha.

In low rainfall zone, the most important cropping system observed includes : cotton/maize; cotton/sorghum; cotton/cowpea; sorghum/groundnut; sorghum/cowpea; millet/groundnut and millet/cowpea. The three-crop system and others patterns are most common in southern sub-zone with higher rainfall, more fertile lixisols and low population density these are: cotton / maize / groundnut or sorghum ; cotton / sorghum / vegetables; Maize / cotton / vegetables; sorghum / groundnut / cotton; sorghum / cowpea / cotton; sorghum / groundnut / cowpea.

Other important enterprises specific to some location include: Muskuwaari / cotton / sorghum and cotton / sorghum / muskuwaari in northern sub-zone. Rice and Muskuwaari are important in low land area.

Labor force

At household level, the resource poor farmers consider labor force one of the most limiting factors. The amount of land a family can cultivate is initially constrained by the amount of labor available to it. Any expansion of production must come either from an increase in the amount of labor from sources outside the family or from an increase in productivity through technological innovation of existing labor sources. The use of animal traction to prepare fields for planting is the most common technological improvement both encouraged by development interventions and employed by farmers.

General knowledge holds that there are distinctly different patterns of labor organization as a function of ethnicity in North Cameroon; non-Foulbé household rely to a greater extent on family labor. They go outside the household for additional labor, they tend to engage exchange labor rather than salaried. Such an understanding does not usually extend to a similar offering of their service to Foulbé farmers. Between the Foulbé and non-Foulbé, a cash market exists. Generally, labors are hired for cotton and Muskuwaari cultivation. The only outside labor input for raining season sorghum is in the harvesting of grain.

Animal husbandry

Livestock constitutes an important component of all agricultural production system in the region, for farmers. Livestock serves as a cash generator for seasonal requirements of agricultural activity. Pastoralism and mixed-crop livestock farming are two extremes along a continuum of livestock production systems found in the region.

Pastoral production in the southern sub-zone function on the basis of periodic movement in search of natural pastures and water, but production strategies often change in accordance with perception of external condition which may result in occasional journeys of short duration or seasonal transhumance lasting several month (Swift, 1977; Horowitz, 1983). During the rainy season, the most productive strategy is to move animals into the drier areas of arid zone to take advantage of the flush of high quality forage produced by annual grasses. During the dry season, pastoralists attempt to access enough water, crop residue and natural forages to maintain the productive capacity of their herds (Sandford, 1982). Within each season they take advantage of the patches of pasture that produce more forage either due to higher soil moisture or fertility (Scoones, 1984). This traditional transhumant production system appears to be in a state of transition and is becoming increasingly difficult to sustain. The problem is not simply of too many animals relative to available grazing areas. Long periods of below average rainfall, recurrent severe droughts and sanitary problems, have decreased pastoralists'herds. In addition, in many part of the region, farmers have taken over the best grazing lands and converted them into cropland. This process has been accompanied by the increasing cultivation of valley bottoms, which has restricted pastoralists movement and prevented them from using these areas as migration routes or pasture during the dry season. This phenomenon is common in all semi-arid region of West Africa (Wilson *et al.*, 1983). The net effect has been a reduction in total pasture area and seasonal inaccessibility to remaining pastures due to diminution caused by cropping. Due to low pasture availability in most of the zone, there is usually a great demand for animal feed, especially during the dry season. Crop residues are the principal source for this, so that in addition to grain, stover also may bring in cash.

Farmers–herds conflicts increase as access paths to local (transhumance) pastures are obstructed. Mixed crop-livestock production systems in the Northern sub-zone are growing in importance as population pressure rises and demand for arable land increases. Farmers look for alternatives to fallow to maintain soil fertility as extensive techniques of soil fertility maintenance become inadequate to meet crop production demand. Farmers prepare their manure in the compounds on the basis of droppings from ruminants and crop residues. Because the quantity of manure produced by farmers is usually insufficient to cover the whole farm in any given years, it is only applied to specific spots in the field, with each field receiving manure in average every two to three years. There is, however, evidence, which indicates that irrespective of the extent of integration of crop and livestock production, many of the direct benefits of closer integration are small (Sandford, 1989, McIntire *et al*., 1992). The notable benefits in improved soil quality and fertility, as result of manuring and the use of animal traction may not always result in large increases in crop yields due to low output response of available crop varieties and the inadequate quantities of manure applied. This may implies that along with closer crop–livestock interactions, new technologies development involving breeding adapted high yielding varieties, and improvement in feed production are needed to raise overall agricultural productivity.

Conclusion

This study was carried out in six benchmark sites, Fignolé, Mafa-kilda, Séboré, Mowo, Gadas, and Balaza-Domayo located in the North and Extreme North province of Cameroon using the rural appraisal survey on the basis of the following aspect: crop and livestock husbandry, land, labor and climatic conditions. It is recognized that all aspect of variability cannot be captured, but with this survey, constraints and opportunities were better identified. It may be observed that in general, high population growth and large number of rainfall deficit years have encouraged extensification of arable farming and heightened the competition between grazing and cropping systems. Moreover, the cultivation of marginal lands and changes in farming systems (e.g. no or shorter fallows) have rendered farmers more vulnerable to climatic risk. In most areas, land allocation to agricultural production is hindered by lack of exclusive use right and land tenure insecurity. It is in light of these developments that an increase in food crop, feed production and quality are needed to improve human nutrition and livestock production in the

region. The integration of grain and forage legumes can serve an important role in sustaining the production of crop and livestock in the region. To this end, mixed crop-livestock systems can be seen as offering solution to the crisis of pastoralism and extensive cropping in the region specifically and generally in all the semi-arid region of the West Africa (Mortimore, 1991).

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